IN-SITU STRIP AND REBUILD OF J2 DIESEL GENERATOR

BY

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Introduction

HMS *Liverpool* deployed to the Caribbean on 6 May 97 to relieve HMS *Boxer* as the West Indies Guard Ship. On 4 June, whilst alongside in Norfolk, Virginia for urgent repairs to the port CPP system, J2 diesel generator was shut down to investigate excessive vibration. Although a defective cylinder liner was initially believed to be the cause, further investigation revealed a failed intercooler and extensive salt water contamination of the diesel. With a pressing requirement to head south into the Caribbean to provide assistance to the volcano-stricken island of Montserrat, coupled with the non-availability of a replacement engine, ship staff were directed to undertake a thorough examination with the intention of achieving an in-situ repair.

Aim

The aim of this article is to outline the key milestones in the strip down and rebuild of J2 diesel generator, highlighting the effort and logistical support required to achieve what, at the outset, appeared a daunting challenge.

Investigation

On initial barring, the engine was found to be partially seized at B2 cylinder. Removal of the crankcase door revealed water falling from the region of the conrod into the sump, indicative of a cracked or shifted liner. However, lifting of the cylinder head revealed that the cylinder was full of salt water. Further investigation determined that all B bank cylinders contained salt water, as did both A and B bank air inlet manifolds. The turbo-blowers showed signs of heavy salt contamination whilst water was evident on the air pass side of B bank intercooler. An oil sample was not only contaminated with salt water, but also with small metallic particles suspected to be white metal. Within 24 hours the engine was significantly more resistant to barring over, indicating partial seizure due to loss of the bearing oil film.

These details having been forwarded to ME213 at Foxhill on the evening of 5 June, the ship received a detailed response the following morning requiring in outline, a thorough fresh water flush of the oil system followed by inspection of numbers 1, 5 and 8 articulations. ME213 expressed their concern that the vibration might have been caused by the hydraulic locking of salt water on top of B bank pistons and that salt water contamination of the main bearings might necessitate an engine replacement. However, in the same signal they also stated that if an in-situ repair was to be undertaken then it would be necessary to replace B bank piston rings and cylinder heads, both turbo-blowers and both intercoolers. At least ship staff knew the options!

On 7 June *Liverpool* sailed from Norfolk and headed south, with the temperature in the machinery space rising rapidly to around 35°C. By 11 June,

when the ship pulled alongside the US Naval Station at Roosevelt Roads, Puerto Rico for fuel, the oil flush had been completed (samples were eventually despatched to DRA Pyestock on 20 June) and inspections confirmed that A bank cylinders were also contaminated, though crankshaft deflections were within tolerance and bearings and articulations appeared sound.

Refuelled, the ship headed directly to Montserrat to recover the advance liaison team and for the Captain to meet the Governor. Meanwhile on 12 June ME213 signalled that the results of the investigation by ship's staff was encouraging and that an in-situ repair was to be attempted, involving the following:

(*a*) The removal of all articulations and replacement of all piston rings.

(*b*) A detailed survey of all conrods for signs of compression or distortion, with replacement of any suspect rods.

(*c*) A survey of liners for excessive wear caused by insufficient lubrication whilst running with salt water in cylinders, replacing as necessary.

(*d*) The cleaning of pistons until free from salt deposits.

(*e*) The compressing of cylinder head valves and washing with fresh water, then PX-24 to remove residual salt deposits.

(*f*) Cleaning of inlet and exhaust manifolds.

(*g*) The replacement of both turbo-blowers.

(*h*) The replacement of both intercoolers.

(*i*) Lub oil flush and filter change on completion of re-build.

(*j*) Heat run and fingerprint test to prove engine, with further lub oil sample to be despatched after 75 hours running.

With the ship due to visit Kingston, Jamaica on 20 June the strip continued under the direction of the ADDIESEL CPOMEA and the ADICE POMEM(M) (S. HAYTER). By 16 June the demands had been raised for 16 pistons and liners, both blowers, both intercoolers and various articulations and bearings. Examination of the cylinder heads indicated that they were recoverable so ship staff gained the approval of ME213 to re-use them, thereby making a significant financial saving with respect to the air freight of replacements. This did however require a major effort from the whole department, with teams responsible for lifting and slinging the heads whilst the refurbishment of each head became the responsibility of an MEM (FIG. 1). To their credit the mechanics rose to the challenge and it became a source of pride to return the best cylinder head. Only one of the 16 heads was condemned.

Whilst the majority of stores arrived in Jamaica there were bound to be logistical difficulties. Coupling clamps could not be delivered before July owing to the supplier's total stock failing a quality inspection. Two small items, critical to the re-build, were only declared available on 18 June and could not therefore be delivered by normal methods. Fortunately SWEO was paying a routine visit so he collected the items and acted as courier! With all the stores being carried on board by hand on a very windy day, two light packages (seals) blew overboard, to be recovered by prompt use of the sea boat! An impressive effort by the logisticians and some interesting slinging operations to manoeuvre the turbo-blowers down to the Forward Auxiliary Machine Room (FAMR) saw *Liverpool* depart from Jamaica on 23 June missing only a replacement B5 bottom bearing.

FIG. 1—MEM DOOLEY CLEANING CYLINDER HEAD

Re-build of J2 diesel

With *Liverpool* heading west for Belize the re-build of J2 commenced (FIGS. 2&3). Even with J1 diesel shut down for the majority of the time, the temperature in the FAMR remained above 35°C. However, the determination and enthusiasm of GARWOOD and HAYTER proved infectious. As well as motivating their dedicated team, they were always willing to accept help from volunteers; one of the chefs became a regular visitor to the FAMR. On 25 June a major eruption of the volcano on Montserrat caught the islanders by surprise, with pyroclastic flows over-running farms and homes. That night, just hours from Belize, *Liverpool* turned east and sped for three days across the Caribbean. Arriving off Montserrat on 28 June a request was received to land a diesel generator repair party, so for the following week efforts were diverted from J2 whilst several portable generating sets were overhauled and set to work for the islanders.

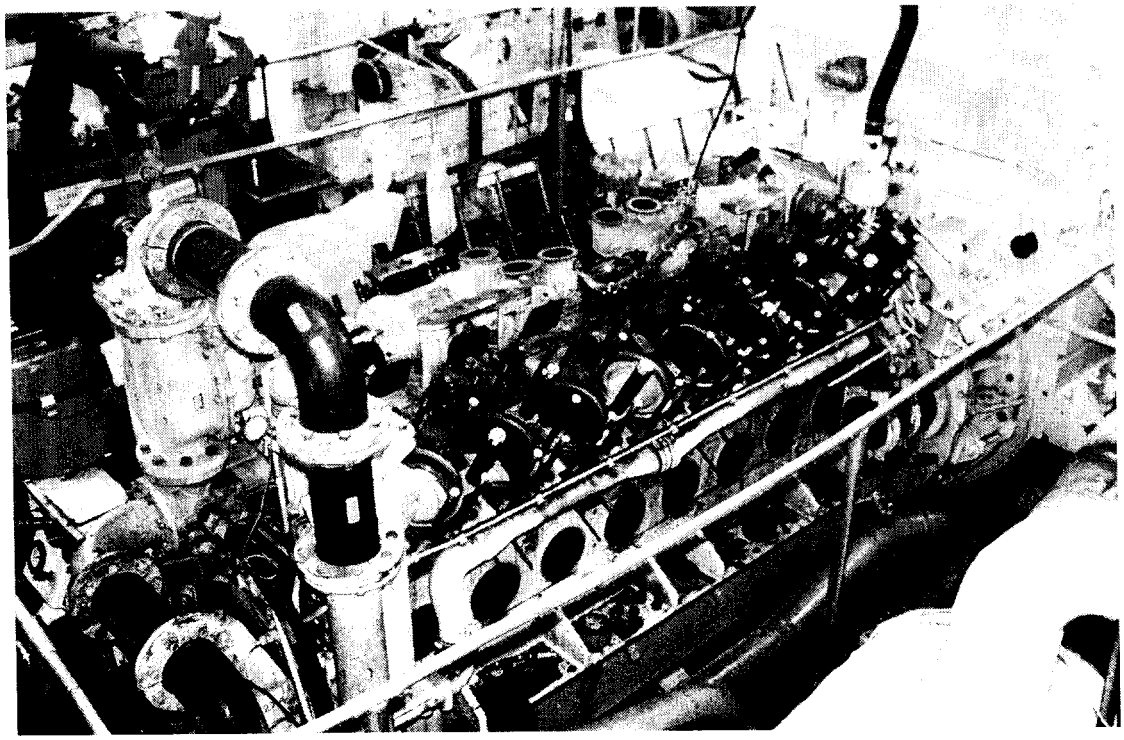

FIG. 2—FAMR—J2 DIESEL REBUILD COMMENCES

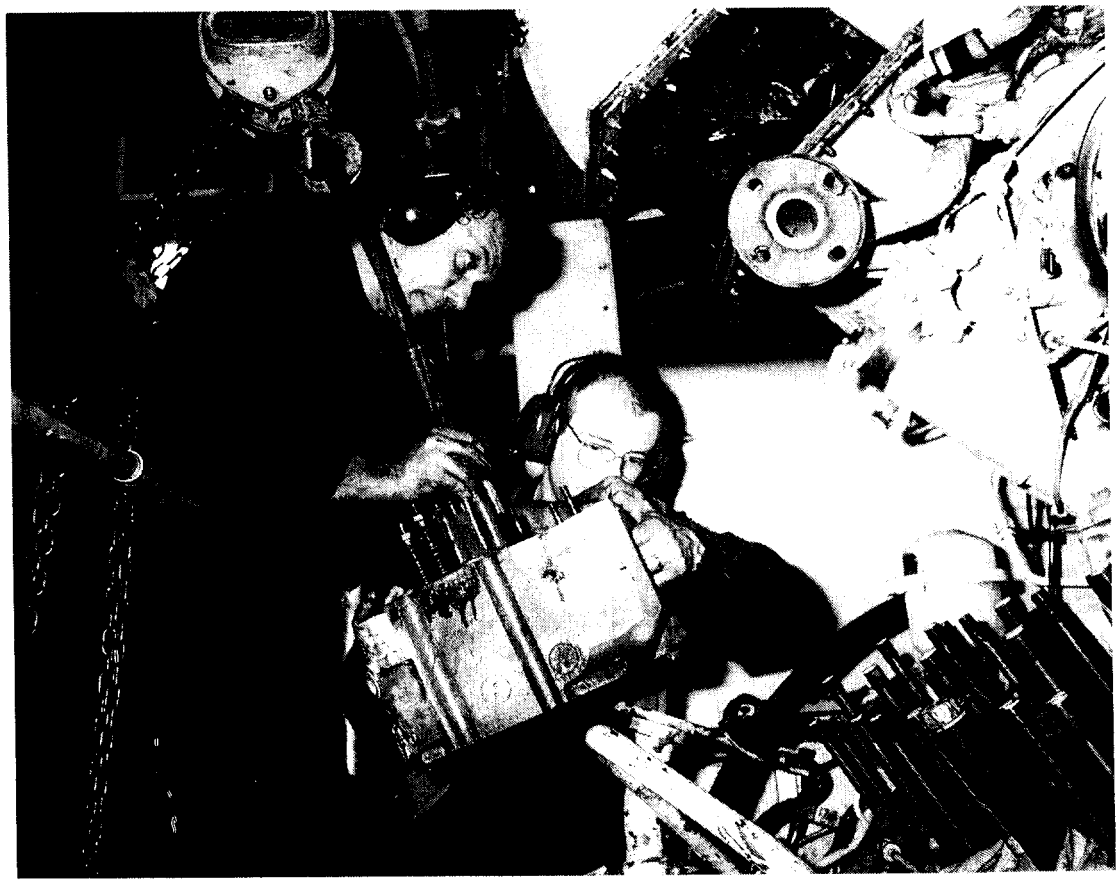

FIG. 3—POMEM HAYTER AND LMEM KING SLINGING CYLINDER HEAD AT SEA

Nevertheless by 3 July all B bank articulations (except B5) had been re-assembled and both turbo-blowers slung into position. Released from immediate tasking at Montserrat on 7 June, *Liverpool* commenced an SMP in Barbados which allowed further progress. Working through visits to Venezuela and St Vincent, the outstanding work on J2 was methodically undertaken, diverting effort as required to keep the remaining three Diesel Generators available and repairing the outboard motors for the ship's boats.

The following components were eventually replaced:

- One small end bearing.
- 16 large end bearings.
- Five connecting rods.
- 16 pistons and liners.
- One cylinder head.
- Two intercoolers and two turbo-blowers.
- Four fuel pumps.

After a thorough oil flush and a successful fingerprint trial, J2 diesel generator was made available to the Command on 7 August.

Conclusion

From the outset it was recognized that this was going to be a major undertaking; one that it was believed had not been attempted previously by any ship's staff, let alone whilst remaining operational in the heat of the West Indies. From the log maintained by CHIEF GARWOOD it was established that members of the Marine Engineering department dedicated over 2,500 hours to the repair of J2 diesel, including over 650 hours by GARWOOD and almost 600 by HAYTER. Despite the high temperatures and the curtailment of potentially attractive visits, morale within the team remained for the most part, at a commendably high level, supported in part by the positive interest shown by the Captain and other members of the Ship's Company and also by the determination to succeed that quickly developed. Distractions that included Captain's Rounds and a fire exercise in the FAMR provided the variety!

It is not known whether the Royal Navy has achieved a financial saving as a result of this repair (although a replacement diesel was not required, subsequent catastrophic failure of the generator may have been attributable to vibration damage whilst the diesel was stripped in-situ). What is known is that the task only succeeded because of the total commitment to completing the project and the pride of those involved. It provided excellent experience for the majority of the department, both from a technical and managerial view.

I would like to conclude by thanking each and every member of my department (in particular CPO GARWOOD and PO HAYTER) for their dedication and resolve.